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ONTARIO AGRICULTURAL COL

BULLETIN 126.

PEAS

AND THE

PEA WEEVIL.

BY

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AND

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THE ONTARIO AGRICULTURAL COLLEGE

AND

EXPERIMENTAL FARM

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CONTENTS.

	PAGE.
Different Uses of the Pea Crop	5
Pea Growing in Ontario	5
Insect Enemies of the Pea Crop	6
Pea-Weevil	6
Pea Moth	6
Pea Aphis	7
The History of the Pea-Weevil in Ontario	8
Loss to Ontario in 1902 by the Pea-Weevil	10
The Decrease in Acreage	10
The Decrease in Yield per Acre	12
The Decreased Market Value of Weevilly Peas	12
The Decreased Value of Weevilly Peas for Feeding Purposes	12
The Small Germinating Power of Weevilly Peas when used for Seed	12
Varieties of Field Peas	13
Selection of Seed	16
Large and Small Seed	16
Whole and Split Seed	16
Sound and Weevilly Seed	17
Dates of Seeding	18
Seed per Acre	19
Methods of Sowing	19
Growing Peas with Other Crops	19
Mixtures for Green Fodder and for Hay	19
Mixtures for the Production of Grain	20
Peas as a Pasture Crop	20
Peas as a Green Manure	21
Substitutes for Ordinary Field Peas in Weevil-infested Districts	21
[illegible]	21
[illegible] Peas	23
[illegible]	24
[illegible]eans	24
Vetches	25
Emmer	25
Other Substitute Crops	25
Treatment of the Pea Weevil	26
Method of Fumigation	26
Effectiveness of Fumigation	26
Escape of the Weevils	27
Carbon Bisulphide	29
Fumigation Box	30
Coal-oil Barrels	30
Bug Houses	31
Other Methods of Treating Peas	32

RECOMMENDATIONS.

The results reported in this bulletin of experiments conducted at the Ontario Agricultural College in growing peas and in combating the pea weevil, as well as the information obtained from some of the most extensive growers, merchants, millers, and exporters of peas in Ontario, lead us to make the following recommendations:

(1) That the acreage of both field and garden peas of the very best varieties be greatly increased in those sections of the Province where there are no pea weevils;

(2) That the growing of both field and garden peas (to be ripened) in the weevil-infested distr' ts of Ontario be discontinued for the next two years, and such crops as Early Yellow Soy beans, Grass peas, Emmer (improperly called Spelt), mixed grains, etc., be substituted;

(3) That if any persons continue to grow and ripen peas in the infested districts, they make the best possible use of the fumigation method;

(4) That seedsmen, farmers, and others send no infested peas into those districts of Ontario where the pea weevil does not exist; and

(5) That farmers, gardeners, seedsmen, millers, exporters, in porters, and all others who have anything to do with the growing or handling of peas in Ontario, co-operate heartily in the effort to eradicate the pea weevil from Ontario within the next two years.

ONT. AGR. COLLEGE,
GUELPH, Ont.

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Ontario Agricultural College and Experimental Farm.

PEAS AND THE PEA WEEVIL.

By C. A. Zavitz, B. S. A., Experimentalist, and Wm. Lochhead, B. A., M. S., Professor of Biology.

The field pea (*Pisum arvense*) is a native of Italy and has been grown in the East from time immemorial. The garden pea (*Pisum sativum*) is regarded by some botanists as a cultivated variety of the field pea. Both kinds have been extensively grown in Ontario for many years, and have been highly prized for their intrinsic value.

Different Uses of the Pea Crop.

Peas are used in, perhaps, a greater variety of ways than any other crop grown in this Province. They are most commonly sown alone, but not unfrequently in conjunction with oats, barley or spring wheat. The crop is occasionally pastured off the land by farm stock, and it is sometimes plowed under to increase the fertility of the soil. When harvested, the unthreshed pea crop may be used as green fodder, or cured and fed in the form of hay. The ripened peas are used extensively for feeding farm stock, or are sold for seed purposes in the foreign as well as in the home markets. Shelled peas, when either green or ripe, are prepared and used in various ways for culinary purposes. The straw of green peas is hauled from the canning factories and fed at once, or placed in the silo, or made into hay; and the straw of the ripened crop is used throughout the winter season for feeding sheep, dairy cattle, and other farm animals.

Pea Growing in Ontario.

The pea crop has undoubtedly occupied a very important place in the agriculture of Ontario. According to the reports of the Bureau of Industries, the average market value of the threshed peas grown in Ontario during the past twenty years amounted to fully eight million dollars a year. In 1897, no less than 896,735 acres were devoted to the pea crop, this being the largest area under peas in any single year. Since that date, however, there has been a gradual decrease until the year 1902, when only 532,639 acres of peas were grown. This decrease is undoubtedly due to the great damage done to the crop in south-western Ontario by the pea weevil, commonly known as the "pea bug."

Insect Enemies of the Pea Crop.

Pea Weevil. Scientifically, the pea-weevil is known as *Bruchus pisorum*, a name given to it by the celebrated Linnæus, who first described the insect sent to him from America. Although called a weevil, its snout is very short; hence, it is not a true snout-weevil.

The adult beetle is scarcely more than one-fifth of an inch in length, and one-tenth of an inch in width. As to color, it is brownish-black, with white and black markings, arranged as in Fig. 1, *d*. Besides the white markings, there are two black spots on the end of its body, which the wings do not cover. When examined closely with a good magnifying glass, the feelers are found to be composed of eleven joints, the sides of the thorax are notched, and the thighs of the hind legs are thickened and provided with two spines.

The beetles make their escape from the peas either in the late summer or spring; the majority probably in the spring. Those that appear in the fall, pass the winter in the barn or under fences or rubbish, or possibly in the ground. When the peas are in blossom, the beetles appear on the vines, and the female deposits her yellow, spindle-shaped eggs on the outside of the young pods. Many eggs are frequently found on a pod, but always singly, and attached by a sticky substance, which becomes white and glistening when dry.

In a few days, the grub hatches from the egg, bores through the wall of the pod, and enters the nearest pea. Within the seed it feeds and grows.

The grub (Fig. 1, a) is maggot-like, being fleshy, slightly swollen in the middle, and white, with the exception of its mouth, which is brown. It has three pairs of minute legs, which are frequently overlooked. When full grown, it is about one-fourth of an inch long. It eats a a circular hole on the side of the pea, leaving only a thin hull as a covering. It then lines this cavity with a thin paste, within which it changes to a pupa.

The pupa (Fig. 1, b and c) is white, but often becomes brown after the peas are threshed and fumigated. The pupal stage is the resting one, and lasts about a week, the exact duration depending largely on weather conditions. It then transforms into an adult beetle, which may either emerge from the pea immediately or remain passive within its cell, even until late in the spring.

Pea Moth. This pea enemy known as the pea moth, (*Semasia nigricana*) is more widely distributed in Canada than the pea-weevil, but it does not work so much injury. This tiny moth (Fig. 2, b and c) is the parent of the small caterpillars, or "worms," which are often found within the pod on the surface of partly eaten and web-covered peas. Besides inflicting injuries to the peas, these "worms" (Fig. 2, a) leave much excrementitious matter in the form of pellets, which render the seeds disgusting and worthless. When nearly full grown,

the caterpillars go into the ground, where they spin a fine cocoon, and remain all winter. In July, the moths emerge, and begin egg-laying a few only being laid on the young pods. The young caterpillars hatch from the eggs in about two weeks.

Late peas are injured most, and sometimes these are badly damaged. (Fig. 2, d). No reliable treatment has as yet been found to control them, but it is advisable to sow early peas, since these are least injured.

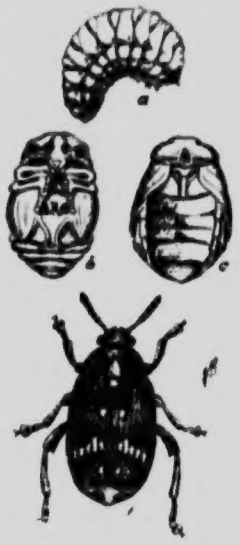

Fig. 1. *Pea Weevil.*—(*a*) The grub; (*b*) the pupa, under surface; (*c*) the pupa, upper surface; (*d*) the adult weevil. (Original.)

Fig. 2. *Pea Moth.* (*a*) A full grown "worm" or caterpillar (enlarged); (*b*) adult moth with wings expanded (enlarged); (*c*) adult moth with wings closed; (*d*) a group of five peas injured by the caterpillars of the pea moth.

PEA APHIS. Within the past few years, the pea aphis, (*Nectarophora pisi*) appeared in several localities in Ontario, especially in Prince Edward, Lennox, Addington, and Wentworth, where it caused considerable loss. In many of the States to the south of us, the losses from this insect were very large. The life history of the "aphis" is interesting, as it spends the first part of the season on clover, migrates to peas in summer, moves back to the clover in the fall, and upon it spends the winter. In Ontario, however, it has done no serious harm to the clover crop. Fortunately it is attacked by several predaceous and parasitic insects, and by a fungus, all of which aid in keeping it in check.

The History of the Pea Weevil in Ontario.

Until recently it was the general belief that the pea weevil was a native of America; but there is a strong reason in favor of its foreign origin. It is not known to feed on any other plant than the cultivated pea, of the genus *Pisum*, which is an introduced plant of Eastern origin. It is likely, therefore, that it came from the East, whence came so many of our cultivated plants, and their insect enemies as well.

The earliest published record of the depredations of the pea weevil in Ontario, so far as we are aware, is that made by the Rev. Geo. S. J. Hill of Markham, in 1857. This gentleman won the second prize (£25) offered by the Legislature of Canada, for an essay on the insects injurious to the wheat crop. Incidentally, in that essay, allusion was made to the pea weevil, which was stated to be one of the most injurious insects to the farm. It is very probable, then, that the weevil even in the fifties was an old offender.

About 1860, the weevil was very injurious in Wentworth county. It is stated that the farmers, almost to a man, at that time gave up growing of peas for two years with the result that the weevil was destroyed. The south-western counties have nearly always suffered most severely; for frequently when the remaining portions of the Province have been entirely free from the pest, the pea crops in the south-western counties have been badly injured.

Rev. Dr. Bethune, editor of the *Canadian Entomologist*, writes us that the weevil has been a familiar insect to him for nearly forty years, and that while he was editor of the entomological column of the "Canadian Farmer," published by the late Hon. George Brown, from 1865 to 1873, he frequently had occasion to give correspondents information regarding the insect. During this whole period of nine years, the weevil was very injurious, especially in the south-western part. In 1870-71, few peas were grown in Essex, Kent, and Lambton, while good crops were common and the weevil was not abundant in the neighborhood of London. Gradually, however, and year by year, the weevil spread north-eastward; and about 1878-1880 most of the farmers in that part of the Province, south of a line drawn from Newmarket to Goderich, were compelled to give up, to a large extent, the growing of peas.

During the years 1885, '86, '87, the weevil did very little injury. The acreage devoted to the pea crop in south-western Ontario was gradually reduced during 1882, '83, and '84, and this may account for the partial disappearance of the weevil during the following years. (Fig 3, c) A few farmers, however, neither stopped growing peas nor fumigated their infested crops; and this was a great mistake, as it prevented a general eradication of the weevil. Along with the in-

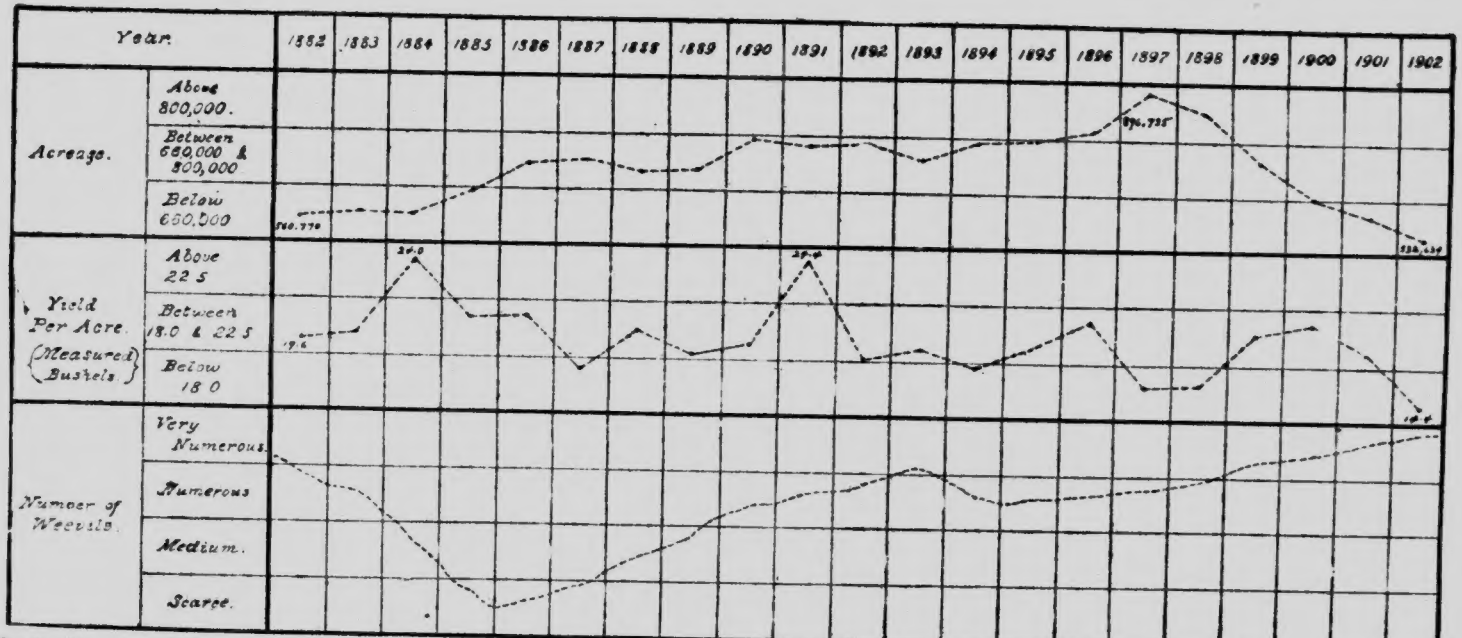

Fig. 3. Diagrams to show the increase or decrease in Ontario of (*a*) the acreage of peas, (*b*) the yield per acre, and (*c*) the number of pea-weevils for the last twenty-one years (1882 to 1902), based principally on the reports of the Bureau of Industries. (Original.)

crease of the acreage from 1886-1890, the weevil increased in numbers and spread rapidly along the Lake Ontario counties to the great pea-growing sections of Prince Edward and Lennox and Addington. During 1892-1893, the weevils were very numerous, but during 1894-1895 there was another decrease in the extent of the injury done. From 1896 until the present, the pest has been on the increase and many sections have given up the growing of peas. Durham, Northumberland and Prince Edward, some years ago, grew large quantities of seed for French and American seedsmen; but the depredations of the weevil became so serious that the growing of peas has, to a large extent, been discontinued in these counties.

There is a larger section of the Province, however, which is free from the weevil. (See Fig. 4.) A line drawn from Brockville to Midland separates the weevil area from the area which is practically free from the weevil. This more northern area includes such fine farming districts as the Ottawa Valley, the Temiscaming district, Parry Sound, Southern Algoma, the Manitoulin and St. Joseph Islands, and the Fort William and the Rainy River districts. This northern area could grow sufficient peas for home consumption, and for our foreign markets, until the pea weevil is eradicated in southwestern Ontario.

LOSS TO ONTARIO IN 1902 BY THE PEA WEEVIL.

It is always a difficult problem to estimate correctly the losses caused by an injurious insect, as several factors of uncertain value must be considered. In the case of the pea weevil, the factors are:

(1) *The Decrease in Acreage.* (Fig. 3). This in itself should not be considered a total loss; for if the land is not sown to peas, it is not lying idle, but is used for the production of some other (often substitute) crop. When we study the statistics of the pea crop of Ontario for the last twenty years (since 1882), we are forced to conclude that the acreage of peas in 1902 is just about one-half of what it would have been if the weevil had not proved destructive. In 1882, the total acreage of peas was 560,770 acres; in 1885, 646,081 acres; in 1888, 696,653 acres; in 1891, 752,453 acres; in 1894, 785,007 acres; in 1896, 829,601 acres; in 1897, 896,735 acres; in 1898, 865,951 acres; in 1899, 743,139 acres; in 1900, 661,592 acres; in 1901, 602,724 acres; and in 1902, 532,639 acres. There was, therefore, a gradual increase from 1882 up to 1897, then a gradual decrease from 1897 to 1902. That this decrease in acreage was due to the pea weevil there can be but little doubt. If we suppose that the area devoted to the pea crop in 1902 should have been about one million acres, according to the natural rate of increase from 1882 to 1897, then there is a decrease of about 500,000 acres in 1902. The decrease in yield would be about 10,000,000 bushels, worth about $6,000,000.

Fig. 4. Infested areas are dotted, the closer the dots the more prevalent the weevil. This map is based principally on reports on Co-operative Experiments throughout Ontario in 1901 and 1902, and by a correspondence carried on in 1902 by the Ontario Bureau of Industries, Toronto. (Original.)

(2) *The Decrease in Yield per Acre.* In a season like that of 1902, when all kinds of pea crops were partial failures, it is difficult to estimate correctly the loss due to the weevil alone. The average yield of peas for the past year was about five bushels per acre less than the average yield for the past twenty years; and it should be understood that the returns sent to the Bureau of Industries are given in measured bushels and not in weighed bushels of 60 pounds.

(3) *The Decreased Market Value of Weevilly Peas.* This is very marked in the south-western part of Ontario where the weevils have done so much injury for a number of years past. As there are large areas in Northern Ontario, however, where peas of excellent quality and free from weevil are still grown, Ontario's reputation as a producer of seed peas of high quality should be maintained. More than half of the territory of Ontario is practically free from the weevil; and with care, our foreign trade in seed peas of superior quality should be increased rather than diminished.

(4) *The Decreased Value of Weevilly Peas for Feeding Purposes.* As a result of a number of examinations, it is found that where weevils have infested all the peas and have afterwards escaped, the seed weighs on an average about 45 pounds instead of 60 pounds per measured bushel, or in other words, the weevils have eaten one-quarter of the peas. In the case of the small peas, such as the Chancellor variety, the injured seed weighed only 37.7 pounds per measured bushel; and in the case of the large peas, such as the Black-Eyed Marrowfat and the New Canadian Beauty, the injured peas weighed from 48 to 52 pounds per measured bushel.

(5). *The Small Germinating Power of Weevilly Peas when Used for Seed.* On an average, only about 30 per cent. of the weevilly peas will germinate. Farmers, however, try to secure sound peas, or use an increased quantity of weevily peas for seed purposes.

The average annual yield of peas per acre for twenty years (1883-1902) is 19.3 bushels, while for the last five years (1898-1902) it is 17.6 bushels. This gives a decrease of 1.7 bushels per acre; and with an area of 532,639 acres in peas in 1902, it represents a loss of over 900,000 bushels, worth over half a million dollars. These amounts do not represent the actual loss in yield, due to the weevil; they simply mean that the loss in 1902 was $500,000 more than it would have been on the same acreage during an average year of the twenty; but the weevil was more or less injurious during all of these years; so the real loss in 1902 due to decrease in yield per acre, would probably be upwards of $1,000,000.

If we group the losses due to the last three factors, we may get a rough estimate, by supposing that one-quarter of all the peas produced in 1902 was destroyed by the weevil and hence made less marketable, less valuable for feeding, and less germinable. The total yield in 1902 was 7,664,679 bushels, worth in round numbers only

$3,000,000, instead of $4,000,000, a loss of $1,000,000. There is, therefore, a total direct loss of over $2,000,000.

In dealing with the probable losses by the weevil we have been very conservative in our estimates. For example, we have attempted to estimate the loss occasioned by the decrease in acreage; but unless the best substitutes for the pea crop are grown, persons engaged in the bacon industry, or the export trade, will be disposed to believe that Ontario suffers a heavy loss in this great decrease.

Varieties of Field Peas.

Upwards of one hundred varieties of peas have been grown in our experimental grounds within the past fourteen years. The greater number of these have been tested for at least five years in succession, after which time the poorer varieties have been dropped and the more valuable kinds have been retained in the experiment.

Varieties.	Color of peas.	Average results for seven (7) years.						
		Weight of 1,000 sound peas. (2 years.)	Time between seeding and ripening.	Length of vines. (5 years.)	Peas containing weevil.	Weight per measured bushel.	Yield per acre.	
							Straw	Peas.
		Oz.	Days.	Inch's.	p.c.	Lbs.	Tons.	bush. 60 lbs.
1. White Wonder	White...	9.5	97	19	34	60.4	1.2	38.2
2. New Zealand Field	White....	7.3	100	36	40	58.5	1.3	37.0
3. Early Britain	Brown ...	10.3	100	39	39	57.8	1.4	36.5
4. Egyptian Mummy	White....	9.1	101	31	25	62.5	1.6	35.3
5. Tall White Marrowfat	White....	9.2	101	41	38	59.6	1.6	34.7
6. New Zealand Brown	Brown . .	10.0	102	39	38	56.8	1.5	34.4
7. Potter	White. ..	8.9	101	43	37	59.5	1.5	33.4
8. New Zealand Blue	Blue	8.9	99	23	36	59.7	1.1	32.9
9. Prussian Blue	Blue	7.1	105	47	34	60 0	1.7	31.8
10. D'Auvergne	White....	7.4	96	40	38	59.1	1.3	31.3
11. White Eyed Marrowfat	White....	8.6	103	41	35	60.4	1.5	31.2
12. Common Grey	Brown	9.8	101	40	34	56.5	1.5	30.7
13. New Canadian Beauty	White....	10 7	101	45	35	60.3	1.4	30.5
14. Chancellor	White....	5.1	94	40	36	58.5	1.3	30.5
15. White Imperial	White. ...	9.2	101	41	35	59.3	1.4	30.2
16. Improved Grey	Brown ...	10.3	100	39	49	56.9	1.4	30.2
17. Canada Cluster	White....	8.9	101	39	29	61.0	1.5	29.3
18. Crown	White....	6.9	100	42	41	58.0	1.4	28.9
19. Black Eyed Marrowfat	White....	10 3	102	39	39	59.5	1.4	27.1
20. Golden Vine	White....	5.2	102	41	33	59 8	1.4	27.1
21. Sword	White...	5.4	104	47	33	59.6	1.6	27.1
22. Centennial White	White....	8.1	104	49	32	60.4	1.5	26.9
23. Multipliers	White....	6.9	105	50	32	60.5	1.8	26.0
24. Prince Albert	White	6.4	109	52	31	60.9	1.7	25.1
25. Striped Wisconsin Blue	M'tl'd blue	7.1	106	46	32	61.2	1 8	25.0
26. Coffee	D'k brown	11.8	102	44	34	57.8	1.5	23.5
		8.4	101	41	35	59.4	1.5	30.6

Careful tests have been made each year, to determine the productiveness, the quality, the resistance of the attacks of the pea weevil, etc., of all the varieties under experiment. The table here presented gives the average results of each of twenty-six of the leading varieties for a period of seven years.

It will be observed from the average results given in the table that there is a great variation in the comparative size of the peas. One thousand seeds of the New Canadian Beauty weighed 10.7 ounces, and a similar number of the Common Golden Vine variety weighed only 5.2 ounces, the weight of the former being more than double that of the latter.

The average number of days between the time of seeding and the time of ripening of all the varieties for the seven years is 101. It will be observed, however, that the Chancellor variety matured in 94 days after planting, and that the Prince Albert required 109 days to reach maturity. There was thus an average of fifteen days between the dates on which the earliest and the latest varieties reached their ripened stage.

In the average length of vines there is a great difference, the extremes being 19 inches for the White Wonder, and 52 inches for the Prince Albert variety. Owing to the extreme shortness of the straw of the White Wonder peas, they are suitable only for very rich soil which naturally grows an abundance of straw. The Golden Vine variety produces a straw which is exactly the same length as the average of all the varieties included in this report.

In each of the past seven years, very careful notes have been taken regarding the average percentage of peas of each variety which were infested with the pea weevil. In order to obtain this information, two hundred peas of each variety were opened on each examination, and the number of weevilly peas was carefully counted. It will be seen from the figures given in the table, that all of the varieties were more or less affected. Those varieties having the smallest percentage of weevilly peas in the average of the seven years' experiments were the Egyptian Mummy, 25 per cent., and the Canada Cluster, 29 per cent. The Egyptian Mummy and the Canada Cluster are varieties very similar in their habits of growth. Those varieties having the greatest number of weevilly peas were the Improved Grey, 49 per cent.; Crown, 41 per cent.; and New Zealand Field, 40 per cent. Of all the peas grown from the twenty-six varieties during a period of seven years, 35 per cent. were weevilly.

Although all the varieties of the peas grown and harvested in the Experimental Department for seven years have been submitted to the carbon bisulphide treatment, and no live weevils have been sown with the peas during that length of time, yet the percentage of weevilly peas in the resulting crops has steadily increased from year

to year. The increased amount of damage done by the weevil to the pea crop for seven years is represented by the following proportions of peas infested with the weevil: 1894, 4 per cent.; 1895, 8 per cent.; 1896, 12 per cent.; 1897, 26 per cent.; 1898, 39 per cent.; 1900, 65 per cent.; and 1901, 89 per cent. While we have been very careful to treat the peas immediately after harvest, some of the neighboring farmers have continued to grow peas, and have not fumigated the crops; hence the marked increase in the number of weevilly peas from year to year. The fact that the percentage of weevilly peas has increased in this district from less than 10 per cent. to practically 90 per cent. in a period of six or seven years indicates what is likely to occur in those districts of Ontario where the pea weevil is just getting a hold, providing no precaution is taken to eradicate it, either by fumigation or starvation. Neither in the Experimental nor the Farm Department of the College were any peas sown in the spring and allowed to ripen in the summer of the present year.

The average weight per measured bushel of all the varieties given in the table is 59.4 pounds. These results have been influenced more or less by the damage done by the weevil; but as the peas were treated immediately after harvest, they weighed heavier than if the weevils had been allowed to complete their work and escape from the peas. As a result of careful examinations which we have made of peas, all of which had been infested and from which the weevils had escaped, we found the weight per measured bushel varied from 38 to 52 pounds according, largely, to the size of the peas; the smaller the peas, the greater the amount of damage done by the weevils.

It will be seen that the average amount of straw produced by the different varieties varied from 1.1 to 1.8 tons per acre. For the average soil of Ontario, those varieties which produce a medium to a large amount of straw, usually give the best satisfaction.

There is, perhaps, no result of the varieties here presented which is more striking than the yield of peas per acre, the highest being 38.2 and the lowest 23.5 bushels. It must be remembered, however, that the White Wonder variety, which stands at the head of the list in yield of peas, is not suitable for the majority of Ontario farms, owing to its short growth of straw. The Egyptian Mummy variety produces a large yield of both seed and straw, but the straw is coarser than that of most other varieties. It will also be remembered that the individual peas of this variety are quite large in size, and that the percentage of weevilly peas was less than that of any other variety.

Within the past nine years, ten varieties of field peas which have given good results in the trial grounds at the college, have been distributed throughout Ontario for co-operative experiments. These

experiments have been successfully conducted on five hundred and seventy-one Ontario farms. Those varieties which have given the largest average yield of grain per acre, each producing upwards of 25 bushels, are the Egyptian Mummy, Chancellor, Prussian Blue, and Striped Wisconsin Blue; and those varieties which have given an average yield of between 24 and 25 bushels per acre are the Early Britain, the Canadian Beauty, and the Canada Cluster.

Each experimenter has been asked to examine the peas carefully for the weevil by splitting open 200 peas from each plot and counting the number of weevils in the form of either little white worms or darkish brown beetles.

From the reports received, we find that, with the exception of a very few scattered places, there is no pea weevil north and east of a line drawn from Brockville to Midland. The accompanying map (page 9) shows the distribution of the insect throughout Ontario, based largely on the reports of our co-operative experimenters for the past two years (1901 and 1902). Reports have been received from all of the districts in New Ontario, and indicate something of the great possibilities of that country in supplying peas of superior quality until the pea weevil can be eradicated from south-western Ontario.

Selection of Seed.

Large and Small Seed. An experiment has been conducted for five years in succession to ascertain the relative value for seed purposes of large and small peas of the same variety. In each of five years, a certain number of large sound peas were carefully selected and counted. A similar number of small sound peas were selected at the same time and from the same variety. The small peas were usually about one-half the size of the large ones In each year, both lots were sown at the same time and on uniform plots of equal size, situated side by side.

The average results for the five years were as follows: Yield of the large seed, 30.3 bushels of grain and 1.3 tons of straw per acre, and that of the small seed, 23.9 bushels of grain and 1.1 tons of straw per acre. A certain number of large peas, therefore, gave 26.8 per cent. more grain, and 18.2 per cent. more straw than a similar number of small peas of the same variety in the average of five years' experiments.

Whole and Split Seed. Many farmers thresh their peas with a grain separator and part of the peas are split in the process of threshing. Some farmers carefully separate the split peas and sow nothing but whole seed; while others sow their peas without making this separation. An experiment has been conducted at the college for eight years in succession by sowing on uniform plots equal quantities of whole and split seed of the same variety. The average results for

the eight years were,—the whole seed, 30.7 bushels of grain and 14 tons of straw per acre, and the split seed, only 10 bushels of grain and 3-5 of a ton of straw per acre.

SOUND AND WEEVILLY SEED. Many observers have noticed frequently that the weevil is not full grown when the peas are harvested, and has not eaten much of the substance of the pea. We have also observed this fact; but very frequently we have observed that the grub is full grown and in the pupa or the imago state, and has done practically all the harm that it is capable of doing.

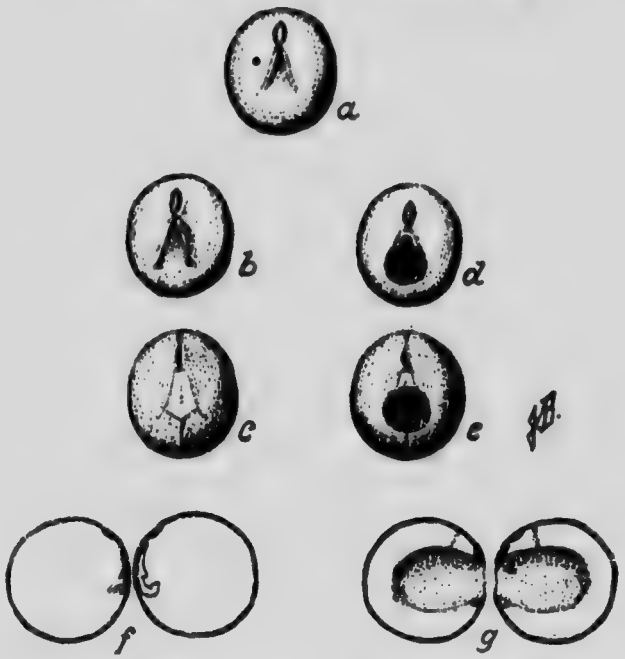

Fig. 5. (*a*) An infested pea showing the spot where the weevil entered; (*b*) a pea not infested, with "skin" on; (*c*) same as (*b*) but with "skin" removed; (*d*) an infested pea showing how the germ is often destroyed by the weevil, "skin" on; (*e*) same as (*d*) but "skin" removed; (*f*) an uninfested pea opened up into halves showing the germ; (*g*) an injured pea opened up, showing how the weevil often destroys both the food and the germ. (Original.)

When the grub is not full grown, the fumigation of the peas will preserve them from further injury; but when the weevil has reached the pupa stage, it has done all the injury of which it is capable.

It is frequently stated that the grub, when working in the pea, avoids the germ or embryo, and that peas which are bored with the weevil are as valuable for seed as those which are not thus injured. Such statements are wholly incorrect. On examining many hundreds of "weevilly" peas at various times, we have found that the great majority of the seeds have their germs completely destroyed, and that

the grubs show no inclination whatever to avoid the germs. (Fig. 5). Moreover, germination tests, carried out on several occasions with injured seeds, have proved conclusively that but a small percentage of them germinate, and a still smaller percentage develop into vigorous plants. In 1897, we found that about three-fifths of the peas of the Marrowfat variety, which had been injured, did not germinate, and that with the Golden Vine variety only thirteen per cent of the peas germinated. If a person were sowing weevily seed of the Golden Vine variety, it would be necessary to sow 15 acres of peas in order to get as many plants as would be produced from sowing two acres with sound seed.

The material has been stored within the seed by the plant for a purpose, and that is, to serve as a food supply for the germinating plantlet. Not until the plantlet has developed both a root system and a leaf system can it prepare food for itself. Up to this period it is entirely dependent on the food stored up in the seed; and it is plain that seeds which have a large portion of their food eaten by the weevil will stand but a poor chance of producing good plants.

Dates of Seeding.

Peas were sown in our experimental plots on six different dates, in the spring of each of six years previous to 1901. One week was allowed between each two seedings. In the average of the six years, the first seeding took place on April 18th, and the last seeding on May 23rd. The average of grain per acre from the six different seedings was as follows:—1st seeding, 26.5 bus.. 2nd seeding, 30.1 bus.; 3rd seeding, 28.8 bus.; 4th seeding 25.5 bus.; 5th seeding, 21.5 bus.; 6th seeding, 19.5 bus. The peas from the different seedings were examined, and it was found that as the season advanced, the percentage of peas containing weevils decreased slightly. In order to get more complete information on this subject, peas were distributed for co-operate experiments throughout Ontario in 1899 and again in 1900, and were sown on four different dates with two weeks between each two seedings. The first seeding took place in the latter part of April and the last seeding in the early part of June. The following are the average results of the various tests made over Ontario for two years:—

Seeding.	Per cent. of Weevilly Peas.	Bushels of Peas per Acre.
1st Seeding	79	21
2nd Seeding	67	17
3rd Seeding	57	13
4th Seeding	41	9

It will be seen that the decrease in the yield of grain per acre is more marked than the decrease in the percentage of weevilly peas.

Seed per Acre.

There is a great difference in the comparative size of the peas of different varieties and also a considerable difference in the character of growth of the plants of the various kinds. It is impossible, therefore, to state any definite amount of seed which will always give the best results with all varieties. While we have obtained excellent results from sowing 2 bushels of the Golden Vine, Chancellor, and Sword peas per acre, which are small seeded varieties, we have found that it is necessary to sow 3½ bushels per acre of the large seeded varieties, such as, the Black-eyed Marrowfat, and New Canadian Beauty, if we wish to get equally good returns.

Methods of Sowing.

Thirty experiments have been made, comparing the results of sowing peas broadcast and with a grain drill. The land has been in a good state of cultivation in every instance. A spring tooth cultivator, which slightly ridges the land, has generally been used immediately before sowing. The average results of the thirty experiments, show that the land on which the seed has been sown with a grain drill has produced one and one-third bushels per acre more than the land on which the peas have been sown broadcast.

Growing Peas with Other Crops.

Mixtures for Green Fodder and for Hay. For six years in succession, peas, oats, barley, and spring wheat were sown separately and in eleven different combinations, for the purpose of ascertaining whether or not better results could be obtained from growing certain crops together than by growing the same crops separately; and also of finding out which mixtures would give the best results for green fodder and for hay. It was found that in fully 90 per cent. of the experiments, the grains which were grown in mixtures gave a larger yield of both green fodder and hay per acre than the same grains sown separately. In the average results of six years' experiments with eleven different mixtures, the greatest yield was obtained from a mixture of peas and oats.

In another experiment conducted for six years, in which nine different proportions of peas and oats were used, it was found that the most satisfactory results were obtained from a mixture of two bushels of oats and one bushel of peas, or a total of three bushels of seed per acre.

Among all the different varieties of peas and oats which have been grown at the College, a few of the most suitable kinds have been selected and grown in combination in order to find out which varieties give the best results for fodder purposes. In an experiment which has been conducted for five years in growing three different

mixtures of peas and oats, comprising early, medium, and late varieties, we get the following results in length of time required to produce fodder of the best quality, and in yield of green fodder per acre: Daubeney oats and Chancellor peas, 70 days, 5.9 tons; Siberian oats and Prussian blue peas, 77 days, 6.9 tons; and Golden Giant oats and Prince peas, 84 days, 6.1 tons. The *Siberian oats and the Prussian Blue peas* form a mixture which has given the best general satisfaction of all the varieties grown together for fodder. By sowing this mixture at different dates in the spring, the time in which the fodder can be used to good advantage can be considerably extended.

Co-operative experiments were conducted over Ontario for five years in succession to test the value of peas and oats (2 of oats and 1 of peas) as compared with tares and oats (2 of oats and 1 of tares) for green fodder. The average yield of green fodder from each acre per annum was 7.9 tons from the former, and 8.2 tons from the latter. It will, therefore, be seen that the mixture of tares and oats surpassed the mixture of peas and oats by an average annual yield of 600 pounds of green fodder per acre.

In those districts of Ontario where the pea weevil does not exist, peas and oats can be grown together satisfactorily for the production of either green or dry fodder. In those portions of the Province where the pea weevil is troublesome, spring tares may be used instead of peas to mix with oats. If, however, peas and oats are grown together for green fodder in the weevil-infested districts, the crops should be cut about the time that the peas have reached the blossoming stage.

Mixtures for the Production of Grain. In the trial grounds at the College, peas, oats, barley and spring wheat were grown separately and in eleven different combinations for the production of grain. This experiment was conducted in duplicate for six years. A mixture of oats and barley gave the greatest yield (2,261 lbs.) of grain per acre; a mixture of oats, barley and peas gave the second highest yield (2,101 lbs.) of grain per acre; aad a mixture of oats and peas gave the fifth highest yield of grain (1,988 lbs.) per acre.

On examining the peas which were grown with the oats, wheat, and barley, we found weevils; but the percentage of weevil was not quite so high as where the peas were grown by themselves.

Peas as a Pasture Crop.

In 1900 and again in 1901, we tested oats and peas, both separately and in combination, for pasture purposes. When the crops were about twelve inches high they were pastured off by cattle. That the green oats were eaten more readily than the green peas was quite noticeable. These crops did not prove very satisfactory as cattle pastures. From observations made we believe that a mixture of oats and peas would perhaps make a suitable pasture for sheep, and that either

peas alone or a mixture of peas and oats would furnish a good pasture for swine.

Peas as a Green Manure.

An experiment was conducted in different parts of the experimental grounds for four different years, to ascertain the relative value of peas, buckwheat and rape for plowing under as green manure for fall wheat. These crops were sown at such times that they would reach the best condition for plowing under by the end of July. After the crops were plowed down each year, the land was cultivated on the surface three or four times during the month of August and the wheat was sown on or about the first day of September.

As the result of four experiments, the average yield of wheat per acre per annum was 36.1 bushels on the pea land, 30.4 bushels on the rape land, and 29.6 on the buckwheat land. It will, therefore, be seen, that the land on which field peas were used as a green manure produced 6½ bushels per acre more than similar land on which buckwheat was used for plowing under.

Substitutes for Ordinary Field Peas in Weevil-infested Districts.

Owing to the ravages of the pea weevil in Southern Ontario, the importance of using substitute crops is becoming pretty generally recognized. Several varieties which might be classed under this heading have been grown in our experimental plots for several years in succession, the results of which are here presented :

Grass Peas. The Grass Pea is a leguminous plant, which produces long, flat vines, slender leaves, white blossoms, medium-sized pods, and hard, angular, white or greenish white, seeds (Fig. 6). It is entirely proof against the attacks of the pea weevil. In many respects it resembles the bitter vetch (*Lathyrus sativus*), of Europe, which, however, has blue flowers, and brown seeds. It also appears to be free from the poisonous principle which the bitter vetch is said to possess. This is borne out by scientific investigations which have been made, and by the extensive and satisfactory use of the Grass peas as a food for farm stock. They are highly prized as a regular farm crop in some sections of Southern Ontario where they have been extensively grown and fed for several years. They have been largely used as a substitute for the ordinary peas in some of those sections where the pea weevil has been doing serious damage for many years. In 1902, however, Grass peas, as well as nearly all other leguminous crops, were a partial failure, owing to the cold, wet weather of the summer. The yield of the Grass peas for 1901 was also below the average in some localities, owing to the excessively hot weather at the time of blossoming. For feeding purposes, they seem to compare favorably with the ordinary field peas. They are usually sown

alone, but sometimes with oats and barley. The crop may be used as green fodder, or as hay, or may be ripened for the production of grain, for which purpose, one and one-half bushels of seed per acre are usually sown with a grain drill. The straw is richer than that of any of the grain crops; and the peas are very hard, but, when ground, make a rich meal that is relished by cattle, sheep, and hogs. The meal of the Grass pea, being rich in flesh-forming constituents, should form not more than about one-third of the entire meal ration for farm stock. In this respect, it is very similar to the meal of ordinary field peas. Grass peas, however, cannot take the place of garden peas for table use, nor of field peas for the export trade.

Fig. 6. The *Grass Pea*, showing the thin, grass-like stems, the white flowers, and the pods containing white, angular peas. (Original.)

The Grass peas have been grown in the trial grounds at the college for at least nine years, and have given good results, except in 1902, when they were a partial failure owing to the cool weather and excessive rainfall. In the average results of tests made for a period of seven years it is found that the annual yield of grain has been 25.7 bushels, and the yield of straw 2.2 tons per acre. In 1900 the yield was slightly over 43 bushels per acre. The grain has been exceptionally heavy, the average weight per measured bushel being about 64 pounds. In comparing the results of the Grass peas with the Golden Vine peas (the common, small, white pea of Ontario), for a period of seven years, we find that the latter has given an average annual yield of 1.4 bushels of grain per acre more than the former; but that the former has given a yield of 4-5 of a ton of straw per acre, and grain which has weighed fully four pounds per measured bushel more than the latter.

In the average results of 27 co-operative experiments conducted throughout Ontario in 1901, the Grass pea gave about 3-4 of a bushel per acre less than the Early Britain variety, and 1-2 bushel per acre more than the White Wonder variety.

To compare the value of Grass peas and Common Tares, or vetches, for green fodder, seed of these varieties was distributed throughout Ontario for co-operative experiments in the years 1897, 1898, 1899, 1900, and 1901 The average results of these experiments for the five years were Grass peas 6.7 tons, and the Common Tares, or vetches, 6.8 tons per acre.

Egyptian Peas. The Egyptian pea is a leguminous plant, grown extensively in the Mediterranean regions, and in Central Asia. It has many common names, such as the Coffee pea, Chick pea, Idaho pea, Gipsy pea, etc., and is scientifically known under the name of *Cicer arietinum*. It has been used as feed for cattle, and also as an article of human food for upwards of 3,000 years. The seed is somewhat larger than that of the common pea, and is enclosed in a short, thick, hairy pod, there being from one to two peas in each pod. The plant itself is seldom used except as a soil renovator, but the yield of grain is large, and is ground into meal which makes a very valuable stock food when fed in much the same way as cotton seed meal. The straw is of little value. As a human food the peas are used in various ways. The ripened grain is sometimes prepared for the table in much the same way that we prepare our Canadien beans for culinary purposes. It is also sometimes roasted and used as a substitute for coffee.

The average results from growing Egyptian peas in our experimental department are a yield of one ton of straw and 35.6 bushels of grain per acre, the grain weighing a little over 62 pounds per measured bushel. It will, therefore, be seen that the Egyptian pea is a large yielder of grain. It is, however, slow in reaching maturity, and pos-

esses straw which is short and of poor quality. The crop is usually slow in maturing, requiring about two weeks longer to ripen than ordinary field peas. As the plants are usually short in growth, the Egyptian peas are suitable only for very rich soil. As was the case with nearly all of the leguminous plants, the Egyptian peas were a partial failure in 1902, owing to the unusually cold, wet weather.

Egyptian peas were distributed for co-operative experiments throughout Ontario for four years in succession. In the average of 180 successfully conducted experiments, the annual yield was found to be only 21.1 bushels per acre. So the Egyptain pea does not seem to be suitable for the average soil of the Province.

Cow Peas. Nearly all the varieties of Cow peas (*Vigna Sinensis*) require such a long season of growth that they are suited only to the warm climate of the south. A few of the earlier kinds have been grown in the Northern States and have been tested at our experiment station at Guelph. We have as yet, however, been unable to find any variety of Cow peas on which we can depend to produce ripened grain, as our season is short, and it is only in exceptional years that even the earliest varieties of Cow peas will mature their seed.

Soy Beans. The Soy beans (*Glycine hispida*); also known under the names of Soja beans, Coffee beans, Idaho peas, etc., have been cultivated in China and Japan for a great length of time. The Soy bean is an annual legume; the plants have an upright growth and are almost completely covered with short hairs. The seed is generally sown at the rate of about one-half bushel per acre in drills from 2 to 3 feet apart, which are cultivated in a similar manner to our Canadian beans. The crop is used for green fodder, or is allowed to ripen for the production of grain, which is exceedingly rich, and when ground into meal is considered about as valuable as cotton seed meal for feeding purposes.

Eight varieties of Soy beans have been imported and grown in our Experimental Department. Some of the varieties have proved to be entirely unsuited for Ontario, owing to the long season required to reach maturity. The Early Yellow Soy bean, however, has given good satisfaction as a grain producer, and the Medium Green variety for the production of green fodder. The average result from growing the Early Yellow Soy beans for a period of seven years, has been 17 bushels of seed per acre. In the production of green fodder, the Early Yellow variety has produced an average of 8 and the Medium Green variety an average of 9.3 tons per acre for the same length of time.

The Early Yellow Soy beans were distributed over Ontario last year for co-operative experiments, and the average yield of grain as produced on thirteen Ontario farms was 21.4 bushels.

We believe it would be a decided advantage to Ontario farmers to grow the Early Yellow Soy beans more generally for the production of grain for feeding purposes; and the Medium Green Soy beans for placing in the silo with corn.

VETCHES. Both the Common Vetches and the Hairy Vetches are serviceable when grown alone or with oats or barley for the production of green fodder, but are not suitable for the production of seed for feeding purposes.

EMMER. This is a species of wheat, known under the scientific name of *Triticum dicoccum*. Emmer is grown at the present day in Switzerland, Germany, Russia, Spain, and some of the other European countries. When the grain is threshed, the heads break at the different joints, leaving the grain in the chaff as closely clasped as ever. To secure the clean seed, special machinery is necessary to separate the chaff from the grain. The flour obtained is said to produce a coarse bread. It is doubtful if Emmer will ever be grown extensively for flour production in Ontario, but the indications are favorable for its becoming a regular and valuable crop for stock feeding. The grain, when ground with the chaff, appears to make a meal of good quality, and the straw is considered by many to make very valuable feed. Emmer is incorrectly called Spelt, or Speltz, by many seedsmen and farmers in Ontario and in the Northern States. The true Spelt (*Triticum spelta*) is quite distinct from Emmer, and is generally considered much inferior.

Different varieties of both Emmer and Spelt have been grown in the experimental grounds at Guelph within the past thirteen years, the former producing good, and the latter, poor results in nearly every case. In the average results from growing Emmer in the trial grounds for the last three years, the yield of grain has been upwards of 2,300 pounds per acre, which is about equal in weight to 68 bushels of oats, or 48 bushels of barley.

Emmer has been distributed throughout Ontario for two years and tested with other kinds of spring wheat. The Emmer surpassed the Wild Goose spring wheat in yield of grain per acre by 46 per cent. in the average of thirty-nine co-operative experiments in 1900, and by 63 per cent. in the average of thirty-one co-operative experiments in 1901. It will, therefore, be seen that Emmer is a large yielder of grain, and that it might be well to give it a trial, especially in those sections where the pea weevil is troublesome.

OTHER SUBSTITUTE CROPS. Besides the different varieties of crops here described, an increased area of our prominent cereals, such as oats, rye, six-rowed, two-rowed, and hulless barley, might be grown, either separately or in various combinations. These crops are too familiar, however, to require any detailed description.

Mixtures composed of oats and barley; oats, barley, and Wild Goose spring wheat; or oats, barley, Wild Goose spring wheat, and Grass peas, which are sown and allowed to ripen, usually yield more per acre than any one of them when grown by itself, or than peas and oats when grown in combination. Mixtures of oats and tares

and of oats and Grass peas, are sometimes used instead of oats and field peas for the production of green fodder and of hay.

Treatment for the Pea Weevil.

Within the past seven years about thirty different treatments of peas have been made in the Experimental Department for the destruction of the pea weevil. In handling the crop, care has been taken throughout to pull the peas at the proper time, to haul them to the barn when dry, and to thresh them as soon as possible. The late varieties have usually been threshed immediately on coming from the field, but the early varieties have sometimes remained in the barn for a few days, or perhaps for even a week. The threshing has usually been done with a machine, but occasionally with a flail.

Method of Fumigation. Immediately after threshing the peas were put into cotton or jute bags. As soon as thirty bushels of peas were threshed they were placed in a fumigation box for treatment. One pound of carbon bisulphide was poured out into three flat pans, which were placed on the top of the peas; the cover was then put on the box and weighted with heavy stones. After forty-eight hours the cover was removed and the box ventilated. The pans had become dry, as the liquid had changed into a gas, which, being much heavier than air, had sunk down amongst the peas penetrating them and killing the weevils. The quantity of carbon bisulphide used by us was larger than that usually recommended, as a pound or a pound and a half is generally considered sufficient for 100 bushels of peas, but we wished to err on the safe side.

Effectiveness of Fumigation. Only once during the seven years did we find live weevils after treatment. In this instance, the treatment was repeated by using one and one-half pounds of the liquid, but again a few live weevils made their appearance. After a third treatment, however, with two pounds of the liquid, no live weevils could be found. We were never able to account for the ineffectiveness of the treatments at this particular time. On all other occasions, the insects were destroyed by the first treatment, no matter whether they were in the larvae form, in the pupa stage, or had become fully developed. We find, from correspondence with a large number of exporters, that the treatment with carbon bisulphide is almost always effectual in killing the weevils with one treatment. One of our exporters, however, writes us as follows:

"Carbon bisulphide treatment has not always been successful in killing all the weevils in the peas. The amount of carbon bisulphide which I have found to give the best results is one gallon to two carloads of peas, or 450 to 500 bags. (This is a little more than one pound to 100 bushels). It is generally assumed that the treatment in the air-tight chamber, or "bug-house," for a period of 24 hours will be effectual. Last year, however, having a quantity of peas for shipment to the English market and being desirous of treating them effectually, I placed them in the "bug-house," and kept them there for nearly a week, and gave them two treatments of carbon bisulphide. After the peas reached England my correspondents there reported that there were still some live weevils in them

I can account for this only on the supposition that at the time of the treatment some of the weevils had not advanced in their development as far as the rest, and that there was less of the inner part of the pea consumed, and that, consequently, the thicker covering protected the weevil from the action of the carbon bisulphide."

The weevils usually die soon after the laying of the eggs on the young pods, but the exact duration of the life of an adult weevil, so far as we are aware, has never been definitely ascertained. It may be that the weevil lives some weeks after the deposition of the eggs.

A somewhat remarkable occurrence of live weevils in peas is told us by a reliable observer. A shipment of peas was fumigated in Ontario, shipped to England, and stored in a seed ware-house. For some reason or other, these peas were left undisturbed for nearly two years; and in the handling of the peas, a few live weevils were found. This case is, of course, abnormal, and simply means that some weevils may survive after two years of torpor, induced by cold; but it also shows that pea-dealers should be exceedingly careful in their shipments, lest some of the live weevils be carried to new districts.

Escape of the Weevils. The time of escape of the weevils from the peas is, unfortunately, so variable and irregular, that it may be said with a great deal of truth that they keep on escaping in July, August and September, and from early April to the beginning of June.

It would be a comparatively simple matter to kill the great majority of the weevils with carbon bisulphide, as explained, if they always remained long enough in the peas to allow for the unavoidable delays in harvesting the crop, threshing the peas, and treating the seed. Some of the weevils may escape, however, before the peas are even harvested. The peas grown on the College Farm, in 1901, were threshed in the field with the College separator on the 15th day of August. The pea crop had not been stacked, but was threshed directly from the land and as soon as it was properly cured; and even at that early date, some of the weevils had escaped from the peas. The unevenness in the development of the weevils in the individual peas of the same crop is likely due to the unevenness in the blossoming of the peas in the different parts of the same field, in the individual plants growing side by side, and in the different parts of the same plants. Several repeated examinations have shown that peas grown on even a small plot in the experimental department and fumigated immediately after they were harvested contained weevils in almost every possible stage of development. To illustrate this fact, the Marrowfat variety has been selected. Two hundred average peas grown and treated in each of four years have been carefully examined. In order to represent the results obtained, four stages in the development of the weevils were selected as the basis of classification. The classification, therefore, is represented as follows: 1. Larva, one-eighth grown; 2. Larva, one-half grown; 3. Pupa; and 4. Adult Beetle, escaped. Every weevil in the peas was placed

in the class which it resembled most closely. The following table gives the results of this examination of the development of the weevils at the time they were fumigated.

Stages in the development of the pea weevils at the time of fumigation.		Average percentage of weevils at each stage of development when fumigation took place.				
		1897	1898	1900	1901	Average 4 years.
	Larva (½ grown)	1	14	7	20	11
	Larva (½ grown)	2	27	10	25	16
	Pupa	47	59	82	53	60
	Adult escaped	50	..	1	2	13

These results are very suggestive. They throw much light upon the probable effectiveness of the fumigation process in the eradication of the pea weevil. It is owing to the irregularity in the development of the weevil that some of the insects escape so early in the season, while others remain in the peas until a much later date.

In some seasons, the weevils develop and escape much earlier than in others. It is quite probable that the conditions of the weather, such as temperature and moisture, exert an influence on their development. In 1902, the weevils did not escape until much later in the season than usual, evidently owing to the wet, cold summer.

Moreover, it is a matter of common observation throughout the country, that many pods shell their peas in the field while the crop is being harvested. If the peas were pulled just before they ripened, not only would there be less shelled peas on the ground, but the straw would be of much better quality. Hogs turned on the pea stubble would eat a few of the scattered peas and the weevils which they contained. If the peas were stirred into the soil by a cultivator, or turned under with a plow, it is quite probable that some of the weevils would be destroyed by this process.

Weevilly peas which remain in the straw after the crop is threshed, which lodge in the separator to be scattered on the ground, which lie on the threshing floor for several days after threshing, etc., give the weevils an opportunity to escape.

In any effort to destroy the pea weevil, attention must be given to garden peas. Most persons do not realize that when a mess of green peas is eaten, a large number of the grubs of the pea weevil are (to put it mildly) prevented from doing further damage. If all the garden peas were eaten in this way and prevented from ripening, there would be no danger to the general pea crop from such a source. An effort should be made, therefore, neither to allow any garden peas to ripen nor any seeds containing live weevils to be planted.

CARBON BISULPHIDE. Carbon bisulphide is a colorless or slightly yellowish liquid, one-fourth heavier than water. It is extremely *volatile*, i. e., evaporates very rapidly when exposed to the air, and when pure will not injure or stain the finest goods. The commercial liquid has an acrid taste, and an odor like that of rotten eggs. The vapor is more than two and a half times as heavy as air. Carbon bisulphide may be purchased in small quantities from any druggist at about 30 cents per pound, or 40 cents per pint. For larger quantities, better rates can be given by the druggist. The gas, or vapor, which comes from carbon bisulphide is not only combustible, but it is very explosive when mixed with air. Great care should, therefore, be taken to treat the peas in the daytime only, for a light or a flame of any kind brought near the liquid may cause a serious explosion; and smoking near it should be positively prohibited. Moreover, the vapor should not be inhaled, as it is very injurious, even a small portion causing headache, giddiness, and nausea. The treatment with carbon bisulphide should be made in boxes, barrels, or "bug houses," located some distance from the insured buildings on the farm.

With the strict observation of the preceding precautions, no one should hesitate to use the carbon bisulphide. As a matter of fact, we have never heard of any bad results following its use in the treatment of peas. This happy condition of things may be explained when we say that all who used the liquid were wise enough to be

cautious. There is, moreover, no danger that the vapor will injure the peas or render them unsafe as food. Experiments have shown that the liquid can even be poured upon articles of food, and, after thorough exposure to the air, not a trace of it will remain.

FUMIGATION BOX. The fumigation box which has been in use in the Experimental Department for seven years for killing the weevil by the carbon bisulphide process is well illustrated in the accompanying diagrams (Fig. 7). The box is rectangular in form,

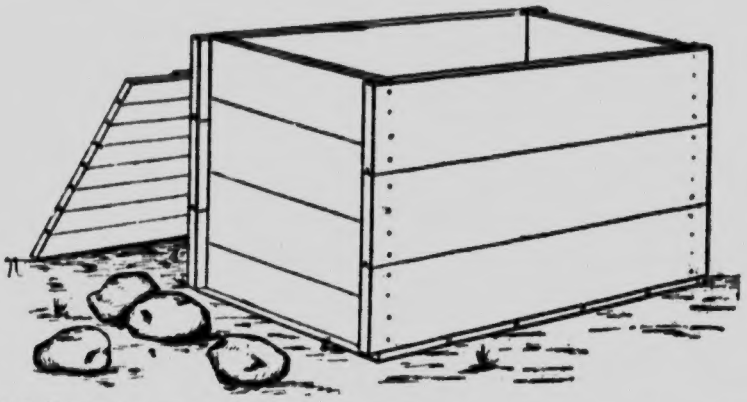

Fig. 7. Fumigation box used in the Experimental Department at the O.A.C. The method of construction is readily seen. (Original.)

being five feet long, two and four-fifths feet wide, and three feet high, and capable of holding about thirty bushels of peas at one time. It is made of pine lumber, 1½ inches thick, tongued and grooved. The end pieces are mortised into the sides. All the joints are made very tight by the use of white lead. The cover is lined with a strip of cloth and is made to fit very closely. This box has been used for the double purpose of fumigating peas to kill the weevils, and of dipping sheep to kill the ticks.

COAL-OIL BARRELS. When a box such as we have described, is not readily made or procurable, one or more *coal-oil barrels* may be used. These are water-tight, and may be covered with a blanket and a close fitting cover, upon which may be placed some heavy stones. Fig. 8 shows the method of using barrels for this purpose. A barrel will hold about five bushels; and for this quantity of peas, three to four ounces of carbon bisulphide are necessary.

This method of treatment is valuable for small quantities of seed peas, but would hardly be adopted when the entire season's crop is to be fumigated, as it would necessitate either a very large number of barrels, or an extended period of fumigation with a few barrels.

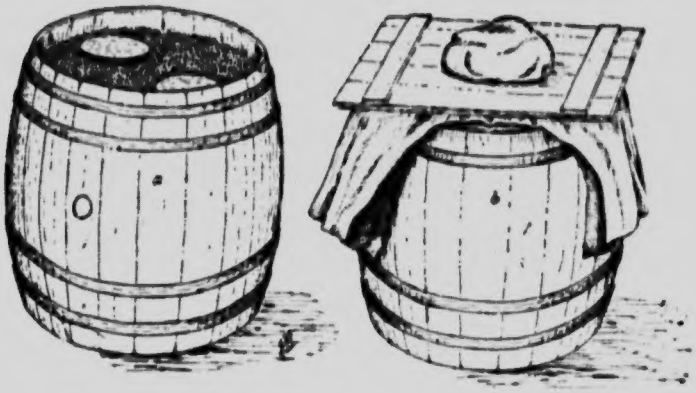

Fig. 8. Method of treating peas in coal-oil barrels. (*a*) Shows the carbon bisulphide in two pans on the surface of the peas; (*b*) ws how the peas are fumigated. (Original.)

BUG HOUSES. Many of our large buyers and shippers of peas have specially constructed air-tight chambers, or "bug houses," in which several hundreds of bags of peas are treated at one time with carbon bisulphide. In some cases, farmers, especially when the pea crop is large, could profitably erect "bug-houses." It is not necessary in all instances to construct a separate building for this purpose. It would be more economical for the farmer to build a compartment in his barn, as it would make tight, clean storage for grain, robes, blankets, or other articles, during the portion of the year when it is not used for treating peas. This may affect insurance.

A chamber 12 feet long, 6 feet wide, and 8 feet high is about the right size for treating the season's crop. Besides the siding on the outside of the frame, there should be two thicknesses of dry tongued-and-grooved matched lumber, with building paper between, well nailed on the outside of the fame. The ceiling should also be made in a similar manner. The beams and joists of the building should be so rigid that they will not give in the least when loaded, lest a crack be made in the side, and allow the gas to escape. The floor should be made of two thicknesses of sound, matched, tongued-and-grooved lumber, with building paper between the thicknesses.

The door-way should have two doors, an inner one not on hinges, but have two handles with which to lift it and put it in place, and an outer one which is hinged. Both of these doors should fit against rubber or felt strips laid on grooves cut in the door-frame. The doors can be wedged tight against the rubber padding by means of three oaken cross bars (at the bottom, middle, and top) which can be driven like wedges into slots cut in the door-casing. (See Fig. 9.)

Other Methods of Treating Peas. The method of *holding over peas* in closed bags or tight boxes for a year is one which has been in operation for many years. The weevils which escape from the

seed soon die, and are not able to lay their eggs in the field. This method is only partially effective, since many weevils make their escape before they can be bagged.

The *boiling water* treatment has also been used for many years. The infested seed is thrown into boiling water for one minute, then quickly removed. This method has never been widely adopted, since the germ is very apt to be injured by longer immersion than one minute in the boiling water.

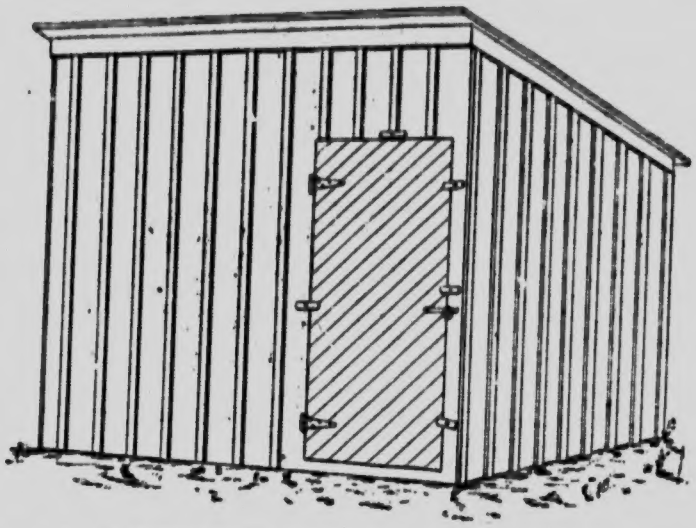

Fig. 9. Fumigation house at the Ontario Agricultural College. There are two doors, one in front and the other in the rear, to facilitate ventilation; the door is driven up tightly against the felted casement by means of large wooden buttons. (Original.)

Infested peas may be treated successfully by *heating* them to a temperature of 145° F. without injury to the germ, but this method has never been widely adopted, for obvious reasons.

Although we have never tried the *coal oil treatment*, some of our correspondents report successful results, and outline the process as here described: The peas are spread on the barn floor in a thin layer about six inches deep; and the oil is sprinkled over the seed through a machine oil-can Then the peas are turned over very thoroughly so that every pea becomes coated with a thin film of oil. In this condition the peas are left for two or three days, when it will be found that the weevils have been killed. One quart of oil is sufficient for twenty bushels of peas.

This method is to be recommended in the treatment of small quantities, such as seed peas; but we are of the opinion that it would not be a practicable method for treating peas in large quantities immediately after harvest.